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DIAGEO PLC
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Patents ADP number *(if you know it)* 8721219001

If the applicant is a corporate body, give the country/state of its incorporation

4. Title of the invention — ADJUSTABLE STAR WHEEL CONVEYOR

5. Name of your agent *(if you have one)* — BOULT WADE TENNANT

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

VERULAM GARDENS
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Patents ADP number *(if you know it)* 42001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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11. I/We request the grant of a patent on the basis of this application.

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12. Name and daytime telephone number of person to contact in the United Kingdom Nick McLeish (0207 430 7500)

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ADJUSTABLE STAR WHEEL CONVEYOR

The present invention relates to an adjustable star wheel and guide rail assembly for use with containers being processed on an automated handling line.

Star wheels are used on various types of automated handling lines to convey containers to and from, and within, various machines, such as rotary packaging machines. In particular, star wheels are used to convey containers between rectilinear conveyors to a rotating machine part and back to a rectilinear conveyor. Such star wheels may be used with a number of containers that include bottles, cans and tins, although it will be realised that this list is not exhaustive. The various rotary packaging machines may perform various functions, e.g. cleaning, filling or labelling a container.

Star wheels derive their name from the shape of one of their type: members of this type are generally disk shaped and their periphery contains a plurality of recesses or pockets thereby forming a star-shape. Such star wheels rotate about a central axis and comprise a pair of disk-like plates centred on this axis. Recesses are provided in the peripheries of the disks to form pockets for receiving containers therein. The star wheel is positioned adjacent an automated handling line so that a container travelling down the handling line is received within a pocket as the star wheel rotates. The container is retained within the pocket as the star wheel rotates before being released at a defined point.

Containers are generally retained within a pocket by supporting the container between a pair of contact surfaces that urge the container against a guide rail that encircles at least part of the star wheel's periphery. A second type

of star wheel provides an alternative forum of support by providing pairs of jaws to grip the container about its sides. This design does not need disks to define peripheral recesses.

A star wheel may convey a container to a closely-defined point within a rotary packaging machine or along a closely-defined path through a rotary packaging machine. For example, the container may be a bottle with a narrow neck that is presented to a filling machine: when presented, the neck of the bottle must be on the correct path such that it passes exactly beneath a filling nozzle.

In general, any automated handling line will be used to process containers of varying shapes and sizes. In the past, each star wheel could only handle containers of a specific shape and size, so this meant having to change the star wheel each time a different container was introduced onto a handling line. This is undesirable as it is both time consuming and necessitates having to keep a stock of different-sized star wheels. Attempts have been made to overcome this problem.

International Patent Application No. PCT/IT99/00072 and US Patent No. 5,743,377 both describe star wheels that use pliers-like jaws for holding round bottles. The jaws have a curvature corresponding to the bottles to be gripped. This design requires the jaws to open in order for a bottle to be received therein before they can close around the bottle. Accordingly, their designs are complicated in that the jaws must be able to open and close around varying ranges of travel to accommodate bottles of any difference in diameter. The jaws are opened and closed via rotation of a cam and the range of rotation of the cam is varied to adjust the range of travel of the jaws. However, only a small range of bottle sizes can be accommodated due to the fact that the

grips must open and close and because the curvature of the grips must correspond to the bottle if a sufficient area of contact is to be made with the bottle to establish a firm grip. The devices of PCT/IT99/00072 and US 5,743,377 also have a further problem in that they are not suited for handling containers that are not round in cross-section.

EP-A-0,412,059 describes an adjustable conveyor comprising a star wheel with a plurality of recesses that make use of radially adjustable push rods to distance a container from the centre of the wheel according to its diameter, in conjunction with an adjustable guide that provides an external restraint. EP-A-0,412,059 may be used with containers of varying sizes but the shape of the push rod means that only a limited range of sizes can be accommodated. For example, where bottles of greatly differing sizes are to be processed, a number of push rods would need to be provided. This necessitates keeping a stock of guide arms and also requires more timely conversion of the star wheel for bottles of greatly differing size.

Against this background, and from a first aspect, the present invention resides in an adjustable star wheel rotatable about a central axis comprising a disk with a periphery, the periphery being shaped to define at least in part a recess for receiving a container therein, the star wheel further comprising a pair of opposed, spaced apart fingers positioned within the recess, each finger providing a contact surface for contacting a container when received in the recess, wherein at least one finger is rotatable with respect to the disk about an axis substantially parallel to the central axis thereby allowing the separation of the fingers to be varied.

The contact surfaces may allow a container to make contact with the fingers in any number of positions, i.e. a

small container will make contact at a pair of points closer together than a larger container. Providing fingers that can rotate apart to give a variable range of separations allows a greater range of sizes of containers to be accommodated. In addition, containers of differing shapes can also be accommodated.

Preferably, both fingers of the pair are rotatable in opposite senses about an axis or axes substantially parallel to the central axis. This allows a greater range of separations to be achieved.

Preferably, both fingers of a pair are rotatable about axes that are circumferentially offset across the recess and, optionally, at least one finger is rotatable about an axis that passes through the at least one finger. Preferably, the at least one finger is generally elongate radially with respect to star wheel and is rotatable about an axis passing through the at least one finger at or towards an end closest to the central axis.

Advantageously, the recess is symmetrical about a centre line corresponding to the radius of the star wheel and the pair of fingers comprise curved contact surfaces whose curvature extends away from the centre line as the fingers extend away from the central axis. This means that larger bottles are accommodated deeper in the recess and this can be exploited such that the centre point of a container remains a fixed distance from the central axis irrespective of the size of the container. In addition, the above combination of features provides contact points with containers that move apart and back into the recess as separation of the fingers increases. Optionally, the radius of curvature of the contact surfaces decreases as the fingers extend away from the central axis.

Optionally, the star wheel comprises a pair of rotatable fingers each provided with a plurality of teeth and wherein the pair of rotatable fingers are rotatable by a common drive means that engages with the teeth of one finger. This provides a simple arrangement for rotating the fingers in unison. Using teeth on both fingers of the same pitch ensures that the fingers rotate through the same angle. The teeth may be provided as separate elements attached to the fingers or they may be integral with the fingers. For example, a corner of the fingers may be provided with teeth or the teeth may be part of a complete cogwheel. Optionally, the teeth of one finger meshes with teeth of the larger drive means in a rack and pinion arrangement.

Preferably, the star wheel further comprises a second recess like the first recess with a finger of the first recess being driveable directly by the drive means and wherein the second recess is located adjacent to the first recess with the teeth a finger of the first recess meshing with the teeth of a finger of the second recess thereby making the finger of the second recess driveable indirectly by the drive means. By 'like', it is meant that the second recess also has a pair of rotatable fingers as described for the first recess. Meshing fingers of adjacent recesses allows one finger to be driven directly by the rack and the other finger to be driven indirectly through the other finger. Advantageously, this results in adjacent fingers rotating in opposite senses, as is required for each pair of fingers to open or close in unison.

Conveniently, the star wheel further comprises a plurality of corresponding recesses forming a never-ending series around the periphery of the disk thereby enabling each finger of each recess to be paired with a finger from

the adjacent recess and wherein one finger from each pair comprises teeth meshed with a larger, common drive means in a rack and pinion arrangement, the drive means being rotatable about the central axis and the other finger from each pair comprising teeth meshed with the teeth of its paired finger. This allows all pockets defined by the fingers to open or close in unison when driven by a single mechanism. This mechanism may be, for example, rotatable by manual adjustment such as by a thumbwheel connected to a further pinion. Optionally, the rack is an annular member.

Advantageously, the rack has an associated travel-limiting means. This ensures that the fingers cannot be driven too far apart or too close together. For example, it may ensure that the fingers cannot be driven into an adjacent structure of the star wheel. Conveniently, the travel-limiting means comprises a circumferentially-extending slot provided in the drive means that receives a member therein.

Optionally, at least one recess is provided with a further pair of fingers positioned within the recess, the further pair being like the first pair and spaced therefrom in the axial direction. This may allow a container to be supported at two levels thereby increasing stability. Advantageously, the axially-spaced pairs of fingers are adjustable independently. This allows containers whose cross-section varies with height to be accommodated.

Conveniently, a finger from the first pair and a finger from the further pair are mounted on a common shaft and, optionally, the shaft may serve as a spacer for a pair of spaced-apart opposed disks having edges that follow a regular meandering path thereby forming the plurality of recesses.

From a second aspect, the present invention resides in an automated handling line guide rail assembly comprising a guide rail defining a limit of a path of a container when conveyed, wherein the guide rail is connected to one cam such that the guide rail is moveable by rotation of the at least one cam at least thereby adjusting the outer limit of the path. This allows containers of varying sizes to be accommodated, for example when used with an adjustable star wheel of the type previously described. Advantageously, it allows the centre point of the container to remain at a fixed distance from the central axis of the star wheel no matter the size of the container.

Optionally, the guide rail is connected to a plurality of cams. The shape of the cams can be tailored to produce the desired range of paths. Conveniently, the assembly further comprises a chain or a belt arranged to rotate the cams. Optionally, the assembly further comprises a pin that passes through a slot provided in the guide rail thereby limiting movement of the guide rail.

Preferably, the assembly further comprises a second moveable guide rail whose shape corresponds to that of the first guide rail and arranged to contact at a second point a container when conveyed, wherein the second guide rail is moveable independently of the first guide rail. When used in combination with a star wheel having two pairs of fingers per recess, the guide rails may be positioned at the same level as the pairs of fingers.

In a currently preferred embodiment, a pair of guide rail assemblies may be arranged in a back to back alignment.

From a third aspect, the present invention resides in a star wheel conveyor comprising an adjustable star wheel and an adjustable guide rail assembly; the star wheel being rotatable about a central axis and comprising a disk with a

periphery, the periphery being shaped to define at least in part a recess for receiving a container therein, the star wheel further comprising a pair of opposed, spaced apart fingers positioned within the recess, each finger providing a contact surface for contacting a container when received in the recess, wherein a finger is rotatable with respect to the disk about an axis substantially parallel to the central axis thereby allowing the separation of the fingers to be varied; and the guide rail assembly comprising a guide rail defining an outer limit of a path of a container when conveyed, at least a part thereof being a fixed distance from the central axis, and wherein the guide rail is moveable thereby adjusting the outer limit of the path. It is to be understood that any of the various preferred features of the star wheel and guide rail assembly described above may be adopted in this star wheel conveyor.

From a fourth aspect, the present invention resides in an automated handling line comprising a rectilinear input conveyor, a star wheel conveyor as described above and a rotary handling machine wherein the star wheel conveyor is arranged, in use, to receive containers travelling along the input conveyor in a recess, to convey the container in a circular path and to release the container on a path tangential to a rotating part of the rotary handling machine.

In order that the invention can be more readily understood, reference will now be made by way of example only, to the accompanying drawings in which:

Figure 1 is a plan view of a pair of star wheel conveyors according to the embodiment of the present invention, each pair comprising a star wheel and a guide rail assembly;

Figure 2 is a perspective view of the star wheel of Figure 1;

Figure 3 is a perspective view of the star wheel of Figure 2 with the upper plate removed;

Figure 4 is a sectional view taken along line IV-IV of Figure 1;

Figure 5 is an exploded view of the star wheel of Figure 2;

Figure 6 is a perspective view of a finger of the star wheel of Figure 2;

Figure 7 is a plan view of the finger of Figure 6;

Figure 8 is a perspective view of the guide rail assembly of Figure 1;

Figure 9 is a plan view of the guide rail assembly of Figure 8;

Figure 10 is a sectional view along line X-X of Figure 1;

Figure 11 is a side view of the guide rail assembly of Figure 8; and

Figure 12 is an exploded view of the guide rail assembly of Figure 8.

A pair of star wheel conveyors 20 according to an embodiment of the present invention is shown in Figure 1: together they convey bottles from left to right. Each pair of star wheel conveyors 20 comprises a star wheel 22 and a guide rail assembly 24. The first pair 20a, shown on the left hand side of Figure 1, define an input path to a rotary packaging machine such as a filling machine (not shown) that comprises a large rotating conveyor whereas the second pair 20b define an output path from the filling machine. The star wheels 22 are identical, but the guide rail assemblies 24 differ because the guide rail assembly 24b on the output leg defines a longer path than on the input leg and is not

provided with adjustable guide rails 26,27. Co-operating formations 28 provided on the guide rail assemblies 24 allow them to be fastened together in a back-to-back arrangement thereby defining the input and output paths relative to each other. Specifically, the input path starts and the output path ends on a common line corresponding to a pair of rectilinear conveyors (not shown) and each path conveys the bottles through an arc of about 135 degrees. The input path will end on a tangent to the rotating conveyor of the filling machine thereby feeding bottles to the filling machine in a smooth and controlled manner. Likewise, bottles are taken from the filling machine tangentially along the output path.

The input star wheel conveyor 20a will now be described in further detail. It will be appreciated that the following description will apply equally well to the output star wheel conveyor 20b and so a description of the output star wheel conveyor 20b will not be given in order to avoid repetition.

The input star wheel 22 has a central axis 30 about which it rotates such that a bottle entering the input star wheel conveyor 20 is received within a pocket 32 formed in the periphery of the input star wheel 22. When the bottle is received with a pocket 32, it is held against a pair of guide rails 26,27 of the guide rail assembly 24. The bottle is also supported from its base by a smooth floor provided beneath the input path (not shown). The centre of the neck of a bottle will follow the path indicated at 34 of Figure 1 no matter what the size and shape of the bottle if the star wheel 22 and guide rail assembly 24 are set correctly (and assuming the neck to be positioned centrally on the bottle).

Figures 2 to 5 show the star wheel 22 in more detail. The star wheel 22 comprises a pair of spaced-apart opposed

disks 36,37. The disks 36,37 have central apertures 38 that allow the star wheel 22 to be mounted on a spindle (not shown). The upper disk's aperture 38 include four inwardly projecting teeth 40 that engage with corresponding formations provided on the spindle such that the star wheel 22 is driven by rotation of the spindle. The peripheral edge 42 of each disk 36,37 corresponds and is broadly circular but follows a regular meandering path thereby defining the upper and lower extent of eight pockets 32. Each pocket 32 is provided with four fingers 44-47: the fingers 44-47 are arranged upper 44,45 and lower 46,47; and left 44,46 and right 45,47. The upper fingers 44,45 are located just below the upper disk 36 and the lower fingers 46,47 are arranged just above the lower disk 37. The fingers 44-47 have smoothly curving inner profiles 48 that project into the pocket 32 defined by the meandering peripheral edge 42 of the disks 36,37. The inner profile 48 is best seen in Figure 7 and forms contact surfaces for contacting a bottle when received within a pocket 32. The curve of the inner profile 48 follows the same broad direction as that of the disks 36,37 thereby creating enlarged entrances to the gap defined between the fingers 44-47. The curve of the inner profile 48 has a decreasing radius of curvature towards the front edge of the finger 44-47 (when looking into the pocket 32).

Each pair of left fingers 44,46 and each pair of right fingers 45,47 are rotatably mounted on a common shaft 50 such that the upper 44,45 and lower 46,47 fingers may be rotated independently of one another. The shafts 50 extend the full height between upper 36 and lower 37 disks and provide a second function in that they act as spacers for the disks 36,37. The shafts 50 are located at the back inside corner of each finger 44-47 such that the fingers 44-

47 may be rotated to widen or narrow the width of the gap that they define. As the upper 44,45 and lower 46,47 fingers may be adjusted independently, the width of the gaps they define may be different. In this way, bottles of greatly varying sizes can be accommodated.

Rotation of the fingers 44-47 is driven by a pair of annular cog wheels 52,53 that are centred on the central axis 30 of the star wheel 22: all upper fingers 44,45 are driven by an upper cog wheel 52 and all lower fingers 46,47 are driven by a lower cog wheel 53. This is achieved by mounting the cog wheels 52,53 on the same level as pinions 54 provided on the corresponding upper 44,45 or lower 46,47 fingers, as shown in Figures 6 and 7. Figure 3 shows that the cog wheels 52,53 are dimensioned so that teeth provided on their peripheral edge engage with the pinions 54 of alternate fingers 45,47 (referred to hereinafter as 'driver' fingers). The cog wheels 52,53 each have four slots 56 and are arranged such that the four slots 56 are aligned. A rod 58 projects through each pair of aligned slots 56 such that the cog wheels 52,53 can rotate about the central axis 30 through a limited angle. This limit of travel of the cog wheels 52, 55 imposes a limit of travel on the fingers 44 - 47 thereby ensuring that they do not inadvertently contact adjacent components. The rod 58 also acts as a spacer for the disks 36,37.

Each cog wheel 52,53 is driven by a thumbwheel 60 provided on a spindle 62 that projects through the upper disk 36. The other end of the spindle 62 is provided with a pinion 64 that engages with the teeth provided on the peripheral edge of its associated cog wheel 52,53. Hence, turning the appropriate thumbwheel 60 drives either the upper 52 or lower 53 cog wheel that, in turn, drives the upper 45 or lower 47 driver fingers. Each pinion 54 has

identical gearing such that all driver fingers 45,47 rotate together through the same angle.

Accordingly, an upper finger 45 and a lower finger 47 from each pocket 32 are connected directly to the upper 52 and lower 53 cog wheels respectively. The remaining fingers 44,46 are driven by the cog wheels 52,53 indirectly. All fingers 44-47 can be paired to their nearest neighbour: as can best be seen from Figure 3, this neighbour will be from an adjacent pocket 32. The pinions 54 from each such pair mesh so that when a cog wheel 52,53 is rotated, the ensuing rotation of a driver finger 45,47 in turn drives rotation of its neighbour 'driven' finger 44,46. As the pinions 54 are the same size, each finger 44-47 within such a pair rotates through the same angle but in an opposite sense as is required (and this is why not all fingers 44-47 are connected directly to the cog wheels 52,53, i.e. this would cause all fingers 44-47 to rotate in the same direction).

The positions of the fingers 44-47 are adjusted whenever a change of bottle size occurs. Once set to the correct position, they may be locked using a thumbscrew 66 of a locking mechanism.

The thumbscrew 66 includes a lower surface that abuts against the upper surface of the upper disk 36. The thumbscrew 66 has a central shaft that penetrates through the upper disk 36, upper and lower cog wheels 52,53 and into a threaded hole provided in the lower disk 37. Cylindrical spacers are provided that fit around the shaft and separate lower disk 37, lower cog wheel 53, upper cog wheel 52 and upper disk 36. The lower part of the shaft is provided with a co-operating thread such that tightening the thumbscrew 66 causes the shaft to sink down into the threaded hole provided in the lower disk 37. This urges the disks 36,37

together thereby clamping the cog wheels 52,53 firmly in place between the spacers.

Turning now to the guide rail assembly 24, this is shown in detail in Figures 8 to 12. As noted previously, a pair of guide rail assemblies 24 are used that connect in back-to-back fashion via co-operating formations 28. Both guide rail assemblies 24 are similar, save for that the output guide rail assembly 24b defines a slightly longer path than the input guide rail assembly 24a and that the output guide rail assembly 24b does not have adjustable guide rails 26,27. Hence, only the input guide rail assembly 24a will be described to avoid repetition.

The input guide rail assembly 24a comprises a pair of spaced-apart opposed plates 80,81. Aligned edges 82 of the plates 80,81 that face the star wheel 22 are shaped to form an arcuate path with smoothly curving lead-in and lead-out portions 84,85 and whose shape and size corresponds to the star wheel 22 as can be seen from Figure 1. A pair of guide rails 26,27 extend along the gap between the rounded edges 82 of the plates 80,81 such that the guide rails 26,27 project slightly in front of the plates 80,81 at the same height as the fingers 44-47 of the star wheel 22. Accordingly, a bottle passing along the input path will contact the guide rails 26,27 rather than the plates 80,81.

As can be seen from Figure 8, the position of the guide rails 26,27 can be adjusted to accommodate bottles of differing sizes. In particular, adjusting the guide rails 26,27 in combination with adjusting the fingers 44-47 of the star wheel 22 means that bottles of differing sizes can be conveyed along the input path with the centre of each bottle still passing along the path shown at 34.

Each guide rail 26,27 is held in position by four cams 86,87. The cams 86,87 are provided as pairs, one upper 86

and one lower 87, each pair 86,87 having a common shaft 88. The upper 86 and lower 87 cams are mounted such that they may be rotated independently. All upper cams 86 are connected by an upper chain 89 and all lower cams 87 are connected by a lower chain 91. The chains 89,91 are housed within recesses 90 formed in the upper and lower plates 80,81, the path of each recess crossing the ends of the shafts 88. Each chain 89,91 contacts a sprocket wheel provided on each cam 86,87, a roller and a sprocket wheel provided on the shaft of a thumbwheel 94. Hence, all the upper 86 or lower 87 cams can be rotated together by turning their associated thumbwheel 94.

The guide rails 26,27 are retained in position between upper and lower flanges 96 provided on the cams 86,87 by a tension spring (not shown) so that their backs rest against an internal wall 98 of the cams 86,87. The internal wall 98 of each cam 86,87 is shaped and the cams 86,87 are aligned such that when the cams 86,87 are rotated, the guide rails 26,27 are pushed forward or backward into or out of the input path (as each guide rail 26,27 is held by four cams 86,87, it cannot simply rotate with the cams 86,87).

The path the guide rails 26,27 follow is also constrained by a shaft 100 that projects through a slot 102 provided in a lobe 104 extending from the rear surface of each guide rail 26,27 towards one end thereof. The shaft 100 is circular in cross-section so that it is received snugly within the slot 102, but so that the guide rail 26,27 can slide relative to the fixed position of the shaft 100. Correct alignment of the cams 86,87 means that the guide rail 26,27 moves in a way that preserves the shape of the input path and merely moves its outer edge closer to the star wheel 22. Rotating the cams 86,87 in the other direction causes the guide rails 26,27 to move out of the

input path as it allows the guide rails 26,27 to be urged back to their former positions by the tension spring. As the upper 86 and lower 87 cams are connected via separate chains, the positions of the guide rails 26,27 in the input path can be set independently.

The shafts, i.e. the shaft projecting through the lobes 100 and the shafts to which the cams are mounted 88, also serve as spacers for keeping the plates 80,81 a fixed distance apart. The shafts 88, 100 are not present in the output guide rail assembly 24b and so separation of its plates 80,81 is achieved using spacer rods 83.

It will now be appreciated that the star wheel 22 and the guide rail assembly 24 can be adjusted to accommodate bottles of different sizes whilst still ensuring that the centre of the bottle follows the path indicated at 34. In addition, the upper 44,45 and lower 46,47 fingers and the upper 26 and lower 27 guide rails can be adjusted independently. This is advantageous for handling bottles of different shapes. For example, consider an example where the star wheel conveyor 20 is adjusted to handle a very large, tall bottle with a short neck (e.g. a one litre bottle of whisky), but where a smaller bottle with a longer neck (e.g. a 250ml beer bottle) is about to be put through the star wheel conveyor 20. Initially, the fingers 44-47 will be set to create pockets 32 of the same size thereby to receive the cylindrical girth of the whisky bottle but will require adjustment to fit the beer bottle. The lower fingers 46,47 may be adjusted to create a narrower pocket 32 for receiving the body of the beer bottle whilst the upper fingers 44,45 may be narrowed even further to receive the neck of the beer bottle. At the same time, the lower guide rail 27 will be moved inwardly towards the star wheel 22 and the upper guide rail 26 will be moved in further still to

define a narrower path for the neck as compared to the body of the beer bottle.

The correct positions of the fingers 44-47 and guide rails 26,27 are pre-determined. However, the thumbwheels 60,94 may be provided with a scale to allow settings for a particular type of bottle to be recorded. Hence, adjusting the star wheel 22 and guide rail assembly 24 for that type of bottle is easily achieved during subsequent changeovers. Moreover, setting the star wheel 22 and guide rail assembly 24 may be performed automatically, e.g. using optical monitoring equipment to ensure contact of bottle, fingers 44-47 and guide rails 26,27 and correct alignment of the neck of a bottle with the path at 34.

In addition to accommodating bottles of differing sizes, bottles of differing shapes may also be accommodated. For example, square or rectangular bottles may be conveyed: rather than forming six points of contact as per a round bottle (one against each finger 44-47 of a pocket 32 and one against the guide rail 26,27, for each of the upper and lower levels), there will be eight points of contact. Moreover, these eight points of contact will define only a single orientation of the bottle (ignoring rotationally symmetric orientations).

The skilled person will appreciate that the above embodiment may be varied in many different respects without departing from the scope of the present invention.

For example, the above star wheel conveyor 20 is described in the context of a bottling line that may be used for presenting bottles for cleaning, filling or labelling. However, the present invention lends itself to many other types of automated handling lines for performing other operations and for processing many types of containers such as those handling cans or tins. The containers may already

be filled when handled by the star wheel conveyor 20 or may be empty or may even be partially filled. The contents (existing or eventual) are largely irrelevant to the present invention. For example, the containers may be for the food and drink industry or may contain many other products. Some obvious examples are perfume, paint, detergents or medicines. Moreover, the products need not be liquid, but could be gaseous or solid (including particulates or powders such as salt crystals or bath salts).

Other details of the star wheel conveyor 20 may be varied. For example, the above embodiment uses a floor to support bottles. However, the floor may not be required where a firm enough grip is provided between the fingers 44-47 and the guide rails 26,27. This arrangement can be helped by making the contact surfaces of the fingers 44-47 from a resilient material. In general, the materials of the various components constituting the star wheel conveyor 20 have not been described. This is because they are a matter of routine choice and may be freely varied according to the purpose of the automated line. For example, some lines may require sterile conditions that will impose strict criteria on the choice of materials.

The cog wheels 52,53 of the star wheel 22 are convenient in that they allow all the upper 44,45 and lower 46,47 fingers to be adjusted synchronously and by the same amount. However, this feature is not essential. Instead, each finger 44-47 may be individually rotatable or pairs of neighbouring fingers 44-47 may be adjusted together. Furthermore, the use of cog wheels 52,53 is not the only way to affect synchronous adjustment of all upper 44,45 and lower 46,47 fingers. A chain linked to chain wheels provided on the fingers 44-47 or a belt that contacts part

of each finger 44-47 could be used to drive the fingers 44-47.

Of course, the ability to adjust the upper 44,45 and lower 46,47 fingers and the upper 26 and lower 27 guide rails independently is useful for accommodating bottles having different sizes at their tops and bottoms, but this feature would be redundant when handling bottles that do not vary in size between top and bottom. In this case, upper 44,45 and lower 46,47 fingers could be fixed to their shafts 50 such that they rotate together, and likewise for the upper 86 and lower 87 cams. Only one thumbwheel 60,94 would be required each for the star wheel 22 and the guide rail assembly 24.

The shape of the fingers 44-47 may be varied from that shown in Figure 7. Whilst arcuate contact surfaces 48 are preferred, the fingers 44-47 may have straight contact surfaces or a rectilinear series of straight contact surfaces.

The guide rail assemblies 24 need not be provided with adjustable guide rails 26,27. In fact this is the case for the guide rail assembly 24 on the output side of Figure 1: rather than having adjustable guide rails 26,27, the peripheral edges 82 of the upper 80 and lower 81 plates act as fixed guide rails for bottles passing along the output path.

Where the guide rail assembly 24 has adjustable guide rails 26,27, the shapes of the cams 86,87 can be varied to create the desired variation in the input or output paths. Generally, the shape will be such that the guide rails 26,27 are pushed into and out of the paths to ensure the necks of bottles follow the path at 34. The number of cams 86,87 may also be varied, although three or more cams 86,87 for each

guide rail 26,27 is preferred. The method of driving the cams 86,87 may also be varied, by using a belt for example.

Whilst the embodiment has pairs of fingers 44-47 at the same height as one of the guide rails 26,27, other arrangements may be adopted. For example, a single pair of fingers 44-47 could be provided at a height intermediate that of the guide rails 26,27, or a single guide rail 26,27 could be provided between pairs of fingers 44-47.

CLAIMS

1. An adjustable star wheel rotatable about a central axis comprising a disk with a periphery, the periphery being shaped to define at least in part a recess for receiving a container therein, the star wheel further comprising a pair of opposed, spaced apart fingers positioned within the recess, each finger providing a contact surface for contacting a container when received in the recess, wherein at least one finger is rotatable with respect to the disk about an axis substantially parallel to the central axis thereby allowing the separation of the fingers to be varied.

2. An adjustable star wheel according to claim 1, wherein both fingers of the pair are rotatable in opposite senses about an axis or axes substantially parallel to the central axis.

3. An adjustable star wheel according to claim 2, wherein both fingers of a pair are rotatable about axes that are circumferentially offset across the recess.

4. An adjustable star wheel according to any preceding claim, wherein at least one finger is rotatable about an axis that passes through the at least one finger.

5. An adjustable star wheel according to claim 4, wherein the at least one finger is generally elongate radially with respect to star wheel and is rotatable about an axis passing through the at least one finger at or towards an end closest to the central axis.

6. An adjustable star wheel according to any preceding claim, wherein the recess is symmetrical about a centre line corresponding to the radius of the star wheel and the pair of fingers comprise curved contact surfaces whose curvature extends away from the centre line as the fingers extend away from the central axis.

7. An adjustable star wheel according to claim 6, wherein the radius of curvature of the contact surfaces decreases as the fingers extend away from the central axis.

8. An adjustable star wheel according to any of claims 2 to 7, comprising a pair of rotatable fingers each provided with a plurality of teeth and wherein the pair of rotatable fingers are rotatable by a common drive means that engages with the teeth of one finger.

9. An adjustable star wheel according to claim 8, wherein the teeth of one finger meshes with the teeth of the larger drive means in a rack and pinion arrangement.

10. An adjustable star wheel according to claim 9, further comprising a second recess like the first recess with a finger of the first recess being driveable directly by the drive means and wherein the second recess is located adjacent to the first recess with the teeth of a finger of the first recess meshing with the teeth of a finger of the second recess thereby making the finger of the second recess driveable indirectly by the drive means.

11. An adjustable star wheel according to claim 10, comprising a plurality of corresponding recesses forming a never-ending series around the periphery of the disk thereby

enabling each finger of each recess to be paired with a finger from the adjacent recess and wherein one finger from each pair comprises teeth meshed with a larger, common drive means in a rack and pinion arrangement, the drive means being rotatable about the central axis and the other finger from each pair comprising teeth meshed with the teeth of its paired finger.

12. An adjustable star wheel according to claim 11, wherein the drive means is an annular member.

13: An adjustable star wheel according to claim 11 or claim 12, wherein the drive means is rotatable by manual adjustment.

14. An adjustable star wheel according to any of claims 11 to 13, wherein the rack has an associated travel-limiting means.

15. An adjustable star wheel according to claim 14, wherein the travel-limiting means comprises a circumferentially-extending slot provided in the drive means that receives a member therein.

16. An adjustable star wheel according to any preceding claim, wherein at least one recess is provided with a further pair of fingers positioned within the recess, the further pair being like the first pair and spaced therefrom in the axial direction.

17. An adjustable star wheel according to claim 16, wherein the axially-spaced pairs of fingers are adjustable independently.

18. An adjustable star wheel according to claim 16 or claim 17, wherein a finger from the first pair and a finger from the further pair are mounted on a common shaft.

19. An adjustable star wheel according to any preceding claim, further comprising a second disk like the first disk, spaced therefrom in the axial direction and positioned such that the at least one recess is aligned.

20. An adjustable star wheel according to claim 19 when dependent upon claim 18, wherein the shaft serves as a spacer between the disks.

21. An adjustable star wheel according to claim 19 or claim 20 when either is dependent upon claim 15, wherein the member serves as a spacer between the disks.

22. An automated handling line guide rail assembly comprising a guide rail defining a limit of a path of a container when conveyed, wherein the guide rail is connected to one cam such that the guide rail is moveable by rotation of the at least one cam at least thereby adjusting the outer limit of the path.

23. An assembly according to claim 22, wherein the guide rail is connected to a plurality of cams.

24. An assembly according to claim 23, further comprising a chain or a belt arranged to rotate the cams.

25. An assembly according to any one of claims 22 to 24, further comprising a pin that passes through a slot provided

in the guide rail thereby limiting movement of the guide rail.

26. An assembly according to any of claims 22 to 25, further comprising a second moveable guide rail whose shape corresponds to that of the first guide rail and arranged to contact at a second point a container when conveyed, wherein the second guide rail is moveable independently of the first guide rail.

27. A pair of guide rail assemblies according to any of claims 22 to 26 arranged in a back to back alignment.

28. A star wheel conveyor comprising an adjustable star wheel and an adjustable guide rail assembly; the star wheel being rotatable about a central axis and comprising a disk with a periphery, the periphery being shaped to define at least in part a recess for receiving a container therein, the star wheel further comprising a pair of opposed, spaced apart fingers positioned within the recess, each finger providing a contact surface for contacting a container when received in the recess, wherein a finger is rotatable with respect to the disk about an axis substantially parallel to the central axis thereby allowing the separation of the fingers to be varied; and the guide rail assembly comprising a guide rail defining an outer limit of a path of a container when conveyed, at least a part thereof being a fixed distance from the central axis, and wherein the guide rail is moveable thereby adjusting the outer limit of the path.

29. The star wheel conveyor of claim 28, comprising the adjustable star wheel of any of claims 2 to 21.

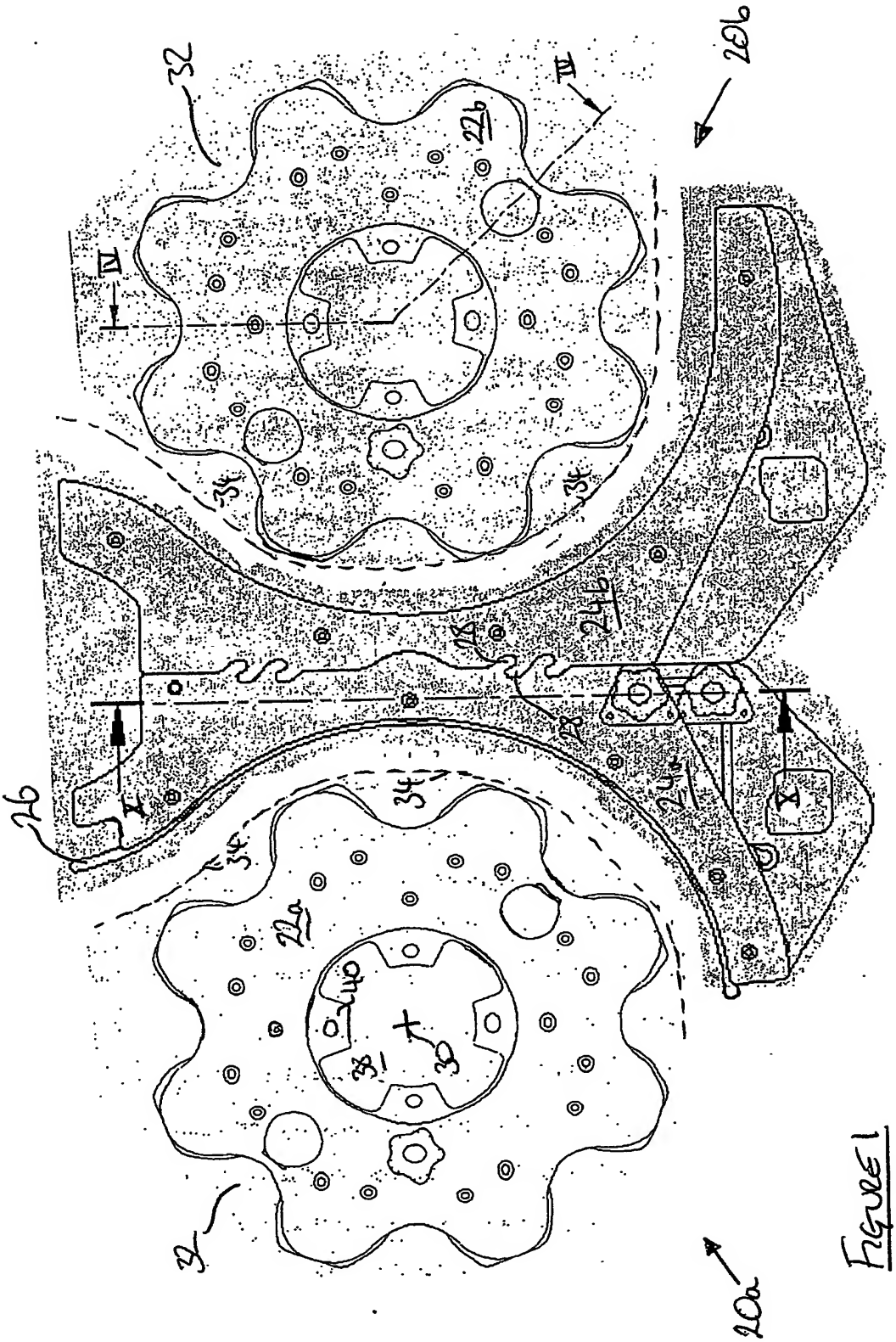
30. The star wheel conveyor of claim 28 or claim 29, comprising the assembly of any of claims 22 to 27.

31. An automated handling line comprising a rectilinear input conveyor, a star wheel conveyor according to any of claims 28 to 30 and a rotary handling machine wherein the star wheel conveyor is arranged, in use, to receive containers travelling along the input conveyor in a recess, to convey the container in a circular path and to release the container on a path tangential to a rotating part of the rotary handling machine.

32. An adjustable star wheel substantially as described hereinbefore with reference to any of Figures 1 to 7.

33. An adjustable star wheel conveyor guide rail assembly substantially as described hereinbefore with reference to any of Figures 1 and 8 to 12.

34. An adjustable star wheel conveyor substantially as described hereinbefore with reference to any of the accompanying Figures.


32
IV
22b
20b
IV
34
34
18
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28
24a
X
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26
34
34
22a
40
38
31
30
32
10a

Figure 1

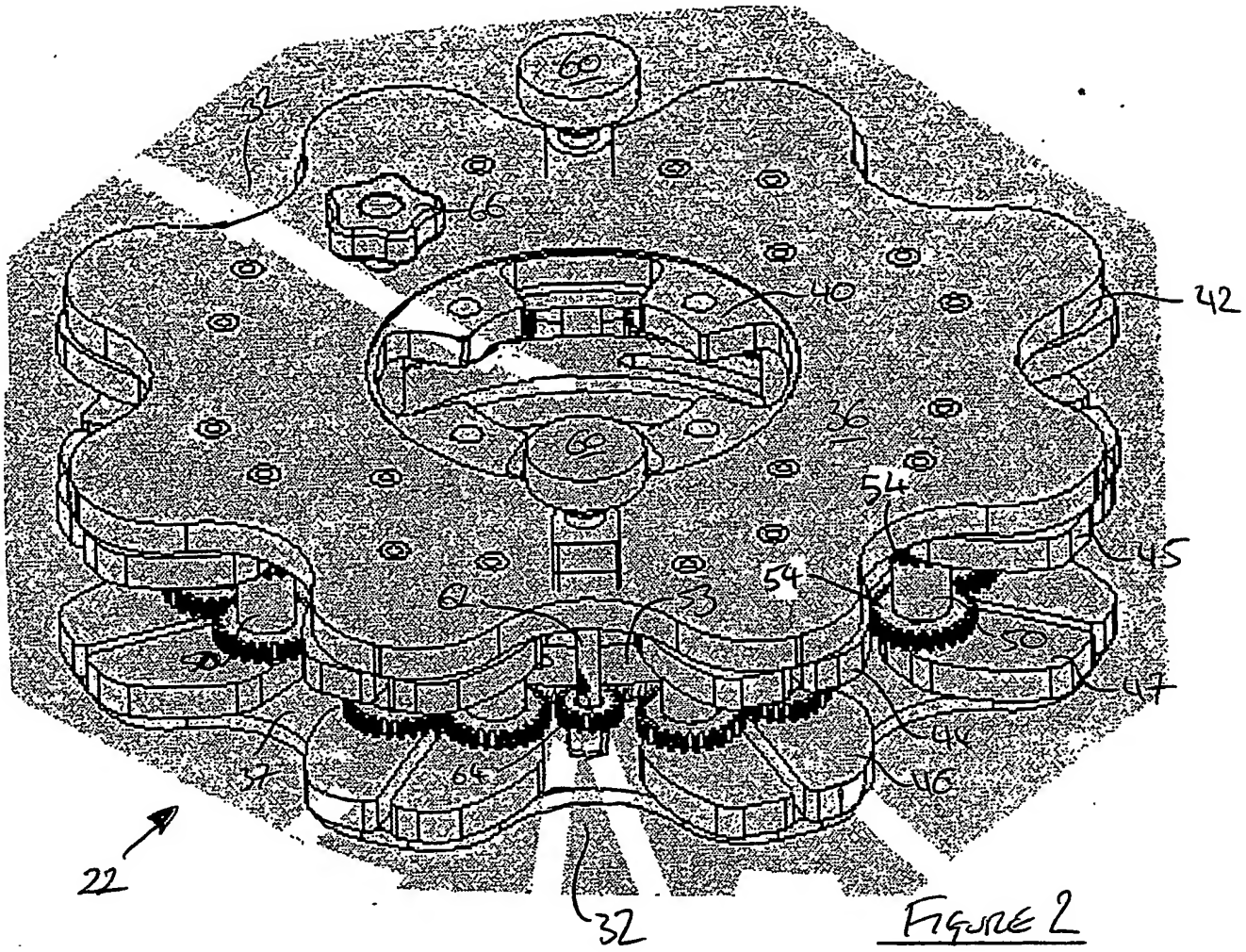


FIGURE 2

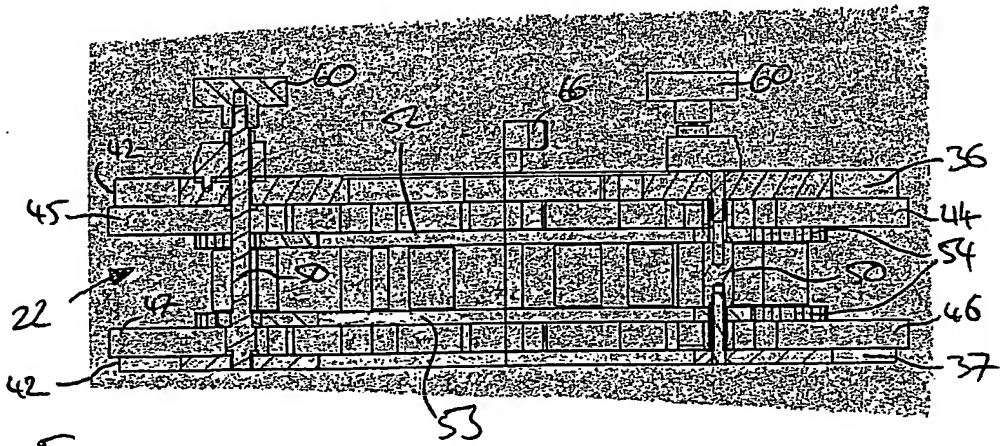


FIGURE 4

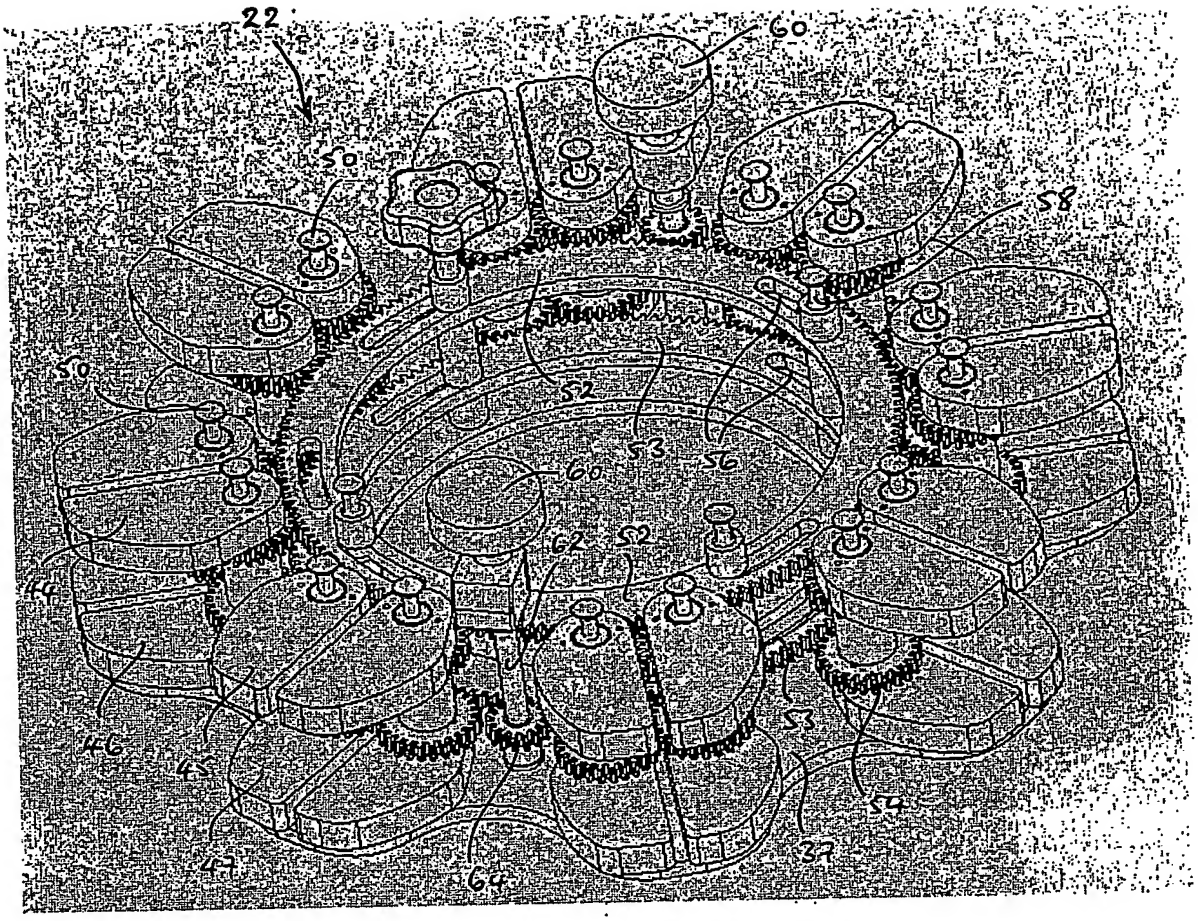
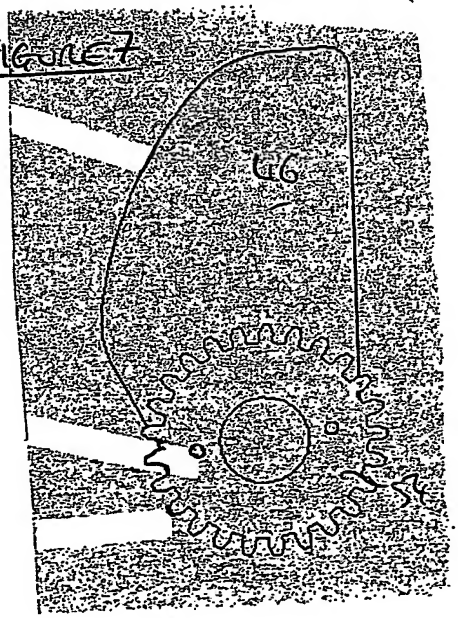


FIGURE 3

FIGURE 7



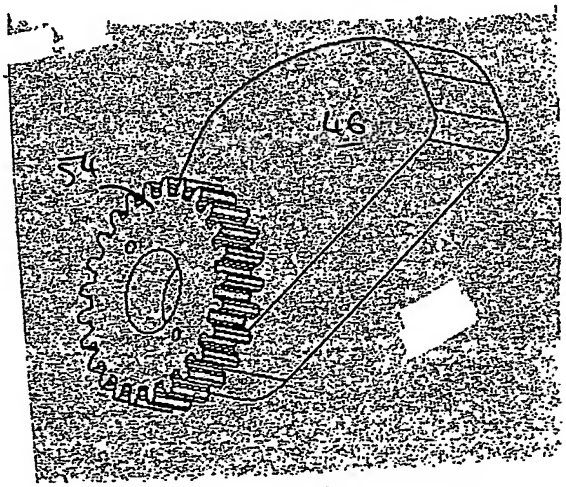


FIGURE 6

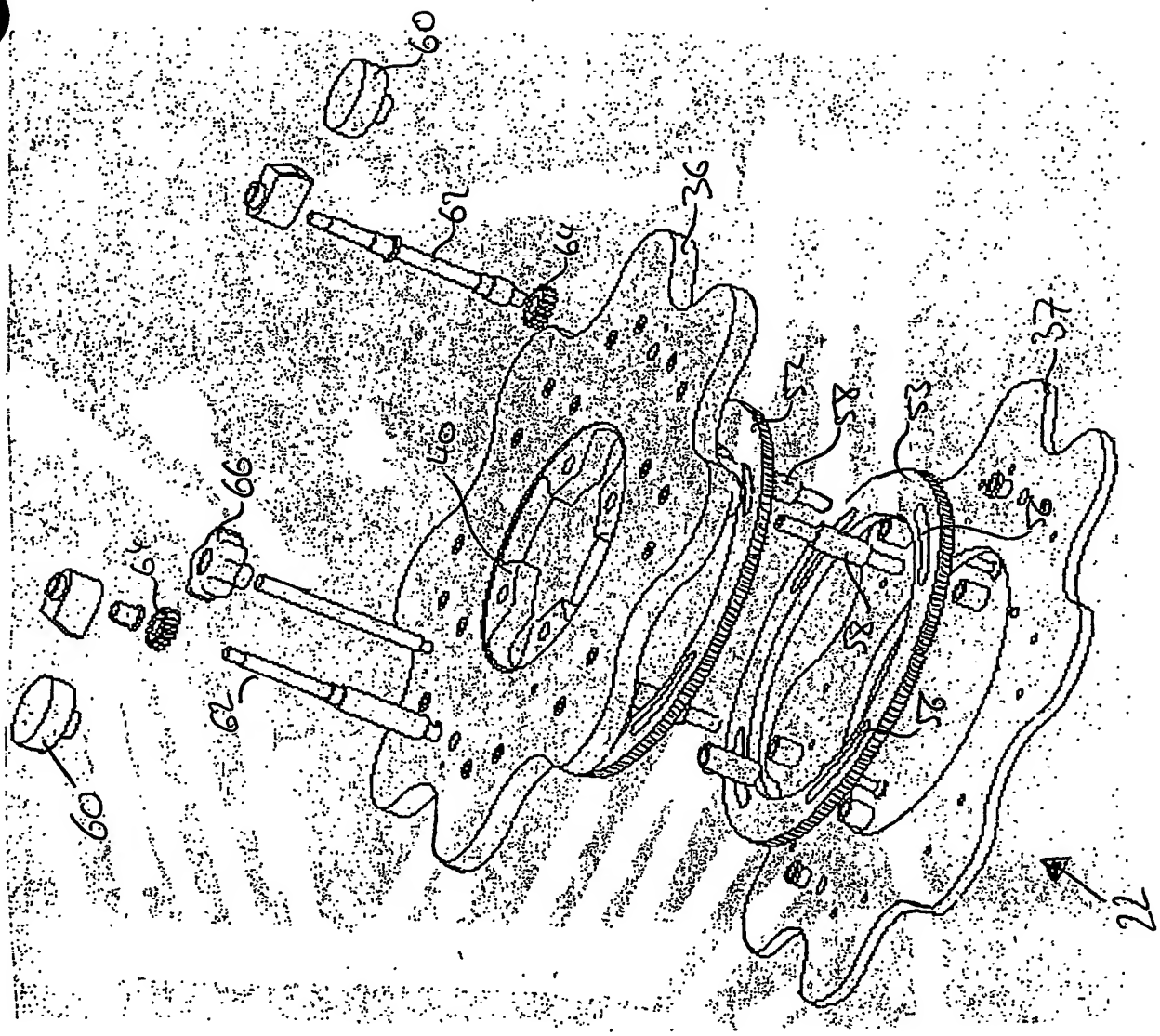
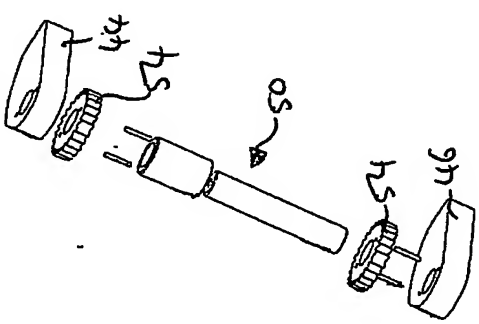


FIGURE 5



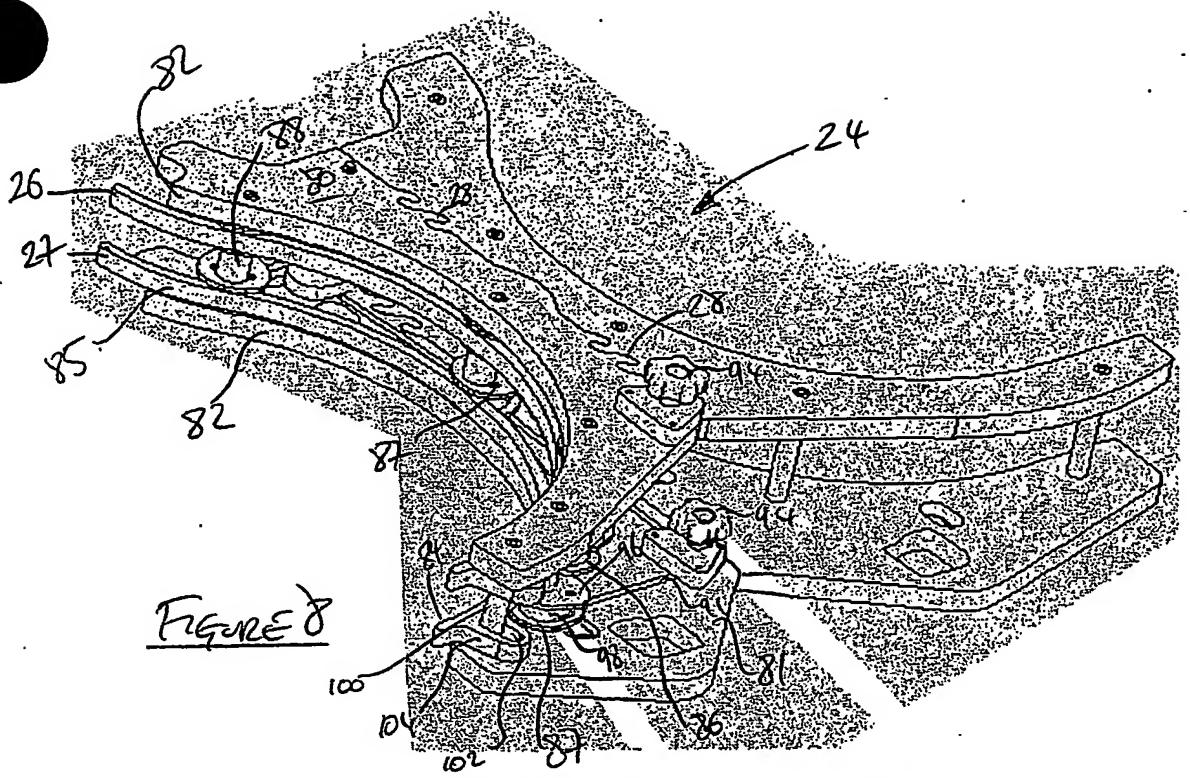


FIGURE 8

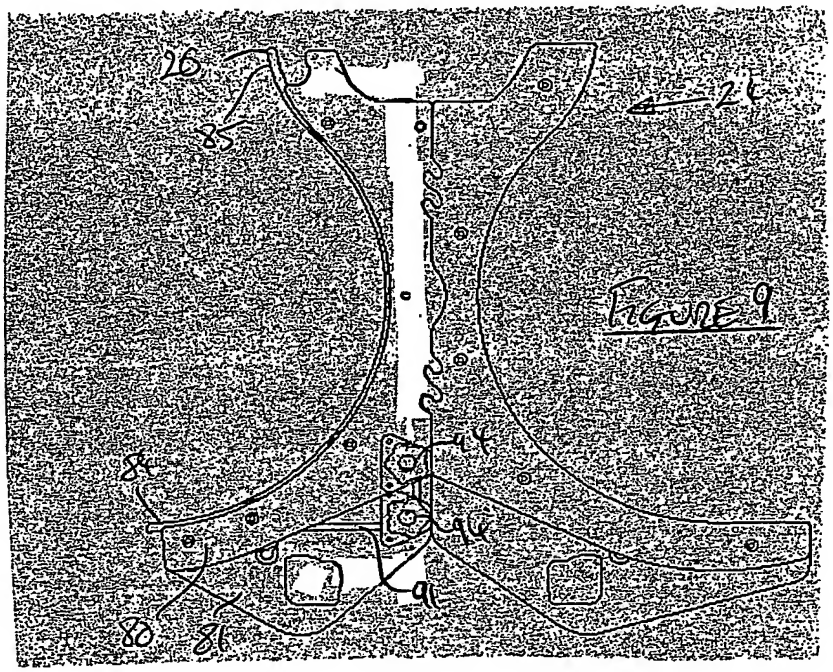


FIGURE 9

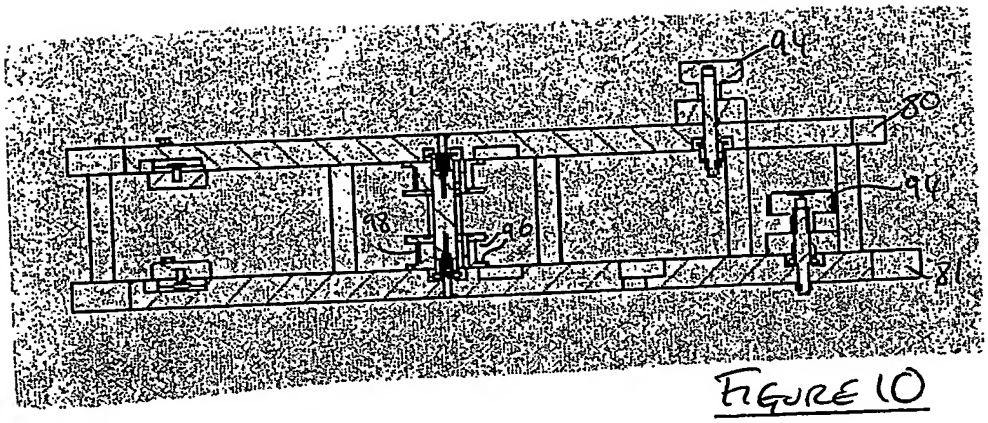


FIGURE 10

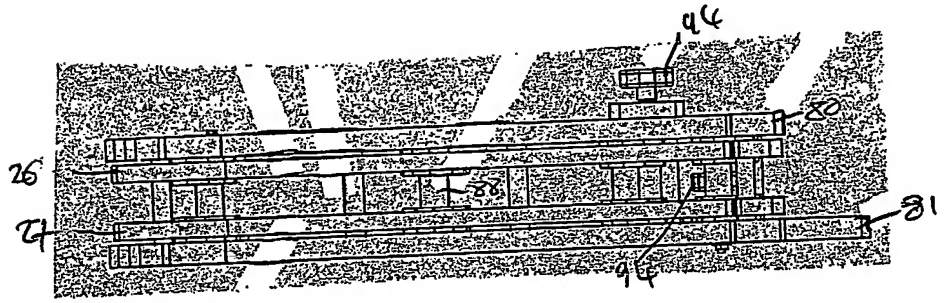


FIGURE 11

FIGURE 12

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